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ABSTRACT

This booklet is second in a series of guides for formative evaluation of education programs. The guide represents a joint project to develop and implement a system for ongoing formative and summative evaluation of the Department of Energy's (DOE) programs to improve precollege mathematics and science education. The guide focuses on the use of the "Template for Teacher Development Programs," which allows for the description of a program and for comparison of that program to best practice. The template identifies what research and experience have been found to work, and is the key tool in the first phase of evaluation of DOE precollege education programs, called "program profiling." Section I covers the development of templates, anatomy of a template, guidelines for use of the template, summarizing the results of the profiling process, and sample questions for profiling teacher development programs. Section II contains the Template for Teacher Development Programs and descriptive and context information. Section III provides operational definitions to clarify the following components and subcomponents of the Template: program administration, vision for the classroom, teacher development program activities, follow-up, teacher leadership, program evaluation, and descriptive and context information. Section IV contains 19 references to research. (LZ)

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Profiling Teacher Development Programs: An Approach to Formative Evaluation

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Profiling Teacher Development Programs: An Approach to Formative Evaluation

The National Center for
Improving Science Education
of
The NETWORK, Inc.
with support from
The United States Department of Energy

November 1993

Profiling Series

This booklet is one of a series of practical guides developed by the National Center for Improving Science Education, in collaboration with precollege program staff from the U.S. Department of Energy's national laboratories and other research facilities, with support from the Department of Energy.

The National Center for Improving Science Education is a division of The NETWORK, Inc., a nonprofit organization dedicated to education reform. The mission of the Center is to promote change in state and local policies and practices in science curriculum, teaching, and assessment. A range of products and services are provided to educational policy makers and practitioners who work to strengthen science teaching and learning across the country.

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Booklets in the Profiling Series

Profiling Teacher Research Participation Programs

Profiling Teacher Development Programs

Profiling Student Programs

Profiling Systemic Programs

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Introduction

This booklet is the second in a series of guides for formative evaluation of education programs developed by the National Center for Improving Science Education in collaboration with the U.S. Department of Energy (DOE). The work described herein is one component of a four-year project. Funded by DOE, this project is a joint endeavor to develop and implement a system for ongoing formative and summative evaluation of DOE's programs to improve precollege mathematics and science education.

In the past several years the DOE has initiated a number of precollege programs serving teachers and students across the country. In 1990, for example, over 200,000 teachers and students participated in DOE-funded activities. The programs draw heavily on DOE's unique capabilities: outstanding scientists, state-of-the-art lab facilities, and research that crosses into frontier science. The precollege teacher programs have two goals: (1) to enhance teachers' knowledge in science and the research process and (2) to strengthen their teaching of science and mathematics in order to enhance student outcomes, including achievement and persistence in pursuing scientific and technical fields.

DOE's large-scale investment in precollege education demands accountability. DOE must know what is actually happening in the programs, what impact the programs are having, and what needs to be done to improve, stabilize, and institutionalize them to contribute to achieving the National Educational Goals.

This booklet is a guide to the process of "program profiling," an approach to formative evaluation used by the National Center for Improving Science Education and developed originally by its host organization, The NETWORK, Inc. The type of program addressed in this guide is teacher development. Similar guides for teacher research participation programs, student programs, and systemic programs are being developed. Although these guides are based on DOE programs, the assessment process and the accompanying instrumentation can readily be applied to similar programs sponsored or conducted by other federal agencies, businesses and industries, nonfederal organizations, and schools or school districts.

The developer of this booklet, the National Center for Improving Science Education, promotes change in state and local policies and practices in science curriculum, teaching, and assessment. In carrying out its work, the Center provides a range of products and services to education policy makers and practitioners who work to strengthen science teaching and learning across the country. In addition to its work in program evaluation, the Center reports and makes recommendations on major trends and reform efforts in science education, is documenting key innovation efforts across the country, and is an active participant in the development and analysis of international studies on curricula, educational practices, and student achievement in science, mathematics, and technology. The Center also provides technical assistance at all levels of the education system, ranging from implementation of formative evaluation to training teachers in hands-on science to improve science education in a district or state.

SECTION ONE

A TOOL FOR PROFILING TEACHER DEVELOPMENT PROGRAMS

Purpose

Significant investments of time, energy, and resources are currently being made in a wide variety of programs that aim to improve education. The Department of Energy is one such investor, with the mission of improving student learning in mathematics, science, and engineering technology through the enhancement of teacher knowledge and skills. A wide variety of programs are currently being funded by DOE that target precollege education, providing unique learning opportunities for both students and teachers. But how good are these programs? Is the funding being invested wisely? What adjustments could be made to better use the available resources and, as resources shrink, where should the cuts be made?

In order to address these important impact questions, a prior question must be answered: *What is actually happening in the programs?* Without the answer to this question, it is impossible to know what is causing either positive or negative learning outcomes. Likewise, it is impossible to know what to change for the purposes of improvement. The *Template for Teacher Development Programs* was developed as a tool to help answer this question.

The template has an additional purpose as well. Instead of allowing only for the description of a program, it also allows for comparison of that program to best practice. The template identifies what research and experience have found to work -- elements that, when part of a program's design, should enhance its effectiveness. Therefore, the template can also help answer another important question about the program: To what extent does it reflect best practice? Addressing this question helps program developers and managers identify components of their programs that could be the focus of improvement.

The template is thus a formative evaluation tool, as well as one of several instruments needed to evaluate the impact of a program. It is the key tool used in the first phase of evaluation of DOE precollege education programs -- called Program Profiling -- and one of several data collection tools used in the second phase -- Impact Assessment.

Development of Templates

The templates for Department of Energy programs have been developed collaboratively, with the National Center for Improving Science Education playing a lead role, and with full participation from precollege education program managers and staff from DOE national laboratories and other facilities. Early in the collaboration, it was determined that there was such a variety of programs that more than one template would be necessary to capture their important features. Several program types were identified in the first discussion: teacher research participation programs, teacher development programs, student programs, systemic programs, and special programs. It was decided that over the course of three years, a template would be developed for each.

Template development begins with searching and reading the literature on each program type, focusing particularly on what research and practice indicate to be components necessary for such programs to be effective. During meetings of DOE and DOE lab staff, readings (mainly syntheses) selected by the Center were discussed and components of effective practice identified through small group work. Center staff combined the work of groups into a draft template and circulated it for review.

It is important to note that some of the program types have not been studied carefully to date, and so some components on the templates are therefore based largely on the experience of program staff. There is a large literature and research base for Teacher Development Programs in general; although limited research is available for Teacher Development in research laboratories conducted by scientific personnel. This is viewed as an opportunity to add to the knowledge base on effective practice; the components listed are being tested for their effectiveness during the evaluation effort.

Once drafted, each template was piloted in several labs. Five labs where Teacher Development Programs were being conducted were selected for the pilot study using a set of criteria developed collaboratively. Center staff read descriptive material about each lab's Teacher Development Program and made site visits during which program staff, teachers, and other key players were interviewed and observed. A template was filled out profiling each lab's program; at the same time, refinements were made in the template. (A *Pilot Profiling Report* is available from the Center.)

Based on learnings from the pilot of how best to use the template to profile programs, the final draft of the template was then used by all labs to profile their own Teacher Development Programs. A summary of the profiles is being compiled by the Center and will be available by mid-1994.

This same process will be used to develop, pilot, and revise the template for each program type. Following the profiling of each type of DOE program, designs and instruments for assessing impact will be developed and tested by the Center in the second phase of this collaborative project. Once the results of the pilot impact assessments are in, the template will be reviewed once more and revised a final time -- this time with a better understanding of the components that make such programs effective.

Anatomy of a Template

The template in Section 2 provides a format for profiling a program as it reflects best practice. It is formatted in three columns. The first column lists Components of Effective Practice, as determined by the template's developers from research and experience. The components are concisely worded, as appropriate to this kind of a tool, and some may find they need clarification and/or elaboration. For this purpose, operational definitions are included (see Section 3) for those terms deemed ambiguous, technical, or uncommon; a reference list (see Section 4) is also included, with the components on the template footnoted as to which reference provides the supporting information.

The second column provides the opportunity to describe the program as it is designed to work, i.e., the Intended Program. The third column, then, is used to describe what happens when the Actual Program is functioning.

Information from these columns can be used to address the following questions:

1. What is best practice for these types of programs?
2. To what extent is the program designed to reflect what is most effective?
3. To what extent does the program in place reflect best practice?
4. To what extent is the program's design actually carried out?
5. Where are the gaps? What can be improved?

The last page of the template provides the opportunity to describe additional characteristics of the program and of its participants that may have an impact on its effectiveness. For example, certain program characteristics may work differently with different teachers (e.g., elementary vs. secondary, experienced vs. novice, teachers of advanced classes vs. general classes), or with different Department of Energy lab characteristics (e.g., hands-on vs. theoretical, high technology-based vs. limited technology).

Particularly important for DOE programs is the description of the unique competencies, facilities, personnel, and other attributes that each program offers to its participants. This is critical to DOE's acceptance, and, indeed, welcome, as an important part in the education of young people in the areas of science, mathematics, and engineering technology. The competencies and capabilities listed here can then be cross-referenced with other parts of the template where they are mentioned. For example, for Teacher Development Programs, the question can be asked: Are science teachers learning in the program something that relates to the "frontier science" being conducted at the lab?

Guidelines for Use of the Template

There are many ways that profiling can be done, depending on the situation. The more people involved, the more this activity can resemble a staff development activity. For example, staff and participants in a program might be asked to complete the template and form discussion groups to share their observations, experiences, and impressions. Or a smaller group of those involved might do the same.

Another option is for program managers to select and interview people; a better option is for program managers to form a small evaluation team representative of the different roles who then select and do the interviews. A final option is to have someone from outside the program do the profiling.

It is important that data be gathered from people in every role (e.g., program staff, teacher participants, mentors, other key participants) and from more than one person in each role. The more people, the fuller the picture.

There is no structured protocol for use by those doing the profiling. They must instead be guided by the information they know they need to acquire for completion of the template. Interviews, observations, and document analysis should be approached in such a way as to achieve this.

Here are some guidelines for Department of Energy lab staff gathering information to complete the template:

1. Review all program materials carefully. There are places in the template that ask for goals, for a description of materials sent to participants, for specific follow-up activities, etc. These materials are important pieces of information.

2. A general note about interviewing: use as many open-ended questions as possible rather than going through the template item-by-item and asking specific questions. (A list of possible interview questions for teachers follows these guidelines, to model what it means to be open-ended.) When you interview you want the interviewee to do as much of the talking as possible.

3. Interview program developers and managers, with a special emphasis on how they have designed the program. What key elements do they think are important? How have those played out? What's actually happening? What has been particularly successful and what less so? How have they changed the elements over the years and why? If they don't mention the specific components from the template, ask them. Be sure to get the descriptive and context information listed on the last page.

4. Interview program participants (teachers, mentors, etc.) to learn what their experiences have been. What seem to be the most important elements of the program? What hasn't worked? How does this kind of experience differ from other professional development programs they've been involved in? If they don't mention the specific components from the template, ask them. (See list of possible questions.) Interview at least 10% of the participants, but no fewer than eight. An alternative is to convene small focus groups of two or three people. In either case, select a cross-section of people, varying on such dimensions as kind of school, attitude about the program, etc.

5. Observe, whenever possible, to get a sense of the environment, the people, the work, the interactions, the facilities, and the stories. Follow up with questions about your observation to enhance the quality and quantity of information.

6. As you complete the template, avoid writing "yes" or "no," but instead describe <u>how</u> the component looks or should look. For example, the item may read, "creates collegial atmosphere." Rather than saying "yes" under Intended Program, you might say "teachers are housed in clusters to promote interaction; once a week lunches are held for all participants and their mentors; Friday afternoon evaluation discussions probe how teachers feel." This kind of response is more helpful than "yes."

Summarizing the Results of the Profiling Process

Data about the program are analyzed and synthesized in a way that is most useful for program managers considering program improvement. At minimum, a template reflects the program as it is intended and as it actually occurs. Conflicting data, e.g., when different people's reports of a given component vary, provide useful information. The following questions can then be asked, in comparing columns on the template:

- To what extent does the program design reflect best practice?
- To what extent are program components actually implemented?
- To what extent does what is happening in the program reflect best practice?
- To what extent does the program take full advantage of the unique capabilities of the Department of Energy lab?
- What changes should be considered in the program, given its goals and constraints?

Sample Questions for Profiling Teacher Development Programs

The purpose of these questions is to provide sufficient information to complete the template's Actual Program column. These are questions for teachers, but many could be adapted easily for mentors and program managers.

As an opener, begin with a general question about the program, for example,

> *If you were going to give a presentation about your experience, what are the four or five things you'd want to be sure to talk about?*

This should give you information about some of the components and some of the sub-components.

Then follow with open-ended questions about each of the components. The questions flow better conversationally than numerically, for example,

(Component 1) Program Administration

> *What do you see as the goals of this program?*

Note: Additional questions for this component are found at the end of this section.

(Component 2) Vision for the Classroom

> *The program you are attending is based on a vision of good science education for kids and includes what a good science program would look like in the classroom. Could you describe that vision or parts of that vision for me? Probe for specifics such as:*
>
> *What would you be teaching?*
>
> *How would you be teaching?*
>
> *What would the kids be doing?*
>
> *What learning outcomes would you be working for?*
>
> *How would you assess what the kids had learned?*
>
> *How would your teaching accommodate the differences in your kids?*

(Component 3) Teacher Development Program Activities

What different approaches are used by those running the program to help you learn? Probe for specifics such as:

How does a typical day go?

What do you do during a typical day?

What opportunities "back home" do you have to practice what you are learning?

(Component 4) Unique Contribution of DOE Laboratories

Teacher development programs are sponsored by a wide variety of organizations. How is this program special (or different) because it is sponsored by the Lab? or What do you think the Lab brings to this program that makes it different from others? Probe for specifics such as:

How do scientists contribute?

How do the facilities contribute?

How does the content differ?

In what ways is the content you are learning linked to the mission of the Lab?

(Component 5) Follow-Up; **(Component 6)** Teacher Leadership and Responsibility

Tell me about your expectations for after the program. What are the expectations for you after you return home? What expectations do you have for support or continued connections to the Lab or Lab staff? Please be specific.

(Component 6) Teacher Leadership and Responsibility; **(Component 7)** Program Evaluation

Have you had any responsibilities beyond those of being a learner in the program such as:

Have you been asked how things are going?

Have you noticed changes in anything that may have resulted from gathering evaluation information from you and other participants?

(Component 1) Program Administration

How have the people in charge of this program made it work for you? Probe for specifics such as:

Were you well prepared?

Were arrangements clear?

What kind of atmosphere have they provided?

Are you clear about any future expectations or follow-up?

SECTION TWO

TEMPLATE FOR TEACHER DEVELOPMENT PROGRAMS

NAME OF FACILITY OR PROGRAM: NAME OF PERSON COMPLETING TEMPLATE: DATE:

Components of Effective Practice	Intended Program	Actual Program
1. Program Administration		
a. articulates clear program goals that are understood by all[2,3]		
b. is clearly assigned as the responsibility of one or more persons		
c. includes teachers, scientists, educators, and administrators in program design		
d. creates collegial atmosphere[10,11,14,15,19]		
e. ensures effective pre-program interaction		
f. ensures effective program follow-up[2,3,14]		
g. communicates with and reports regularly to DOE		
h. maintains database of participant information		
i. establishes relationship with teacher's school/district[4,14,15,19]		
j. designs and conducts participant recruitment so teachers representing the target population (e.g., those teaching students from underrepresented groups) are reached		

Components of Effective Practice	Intended Program	Actual Program
2. Vision for the Classroom (promoted by the program) emphasizes a. deep understanding by students of major science concepts or principles, development of skills, and "scientific habits of mind"[1,2,3] b. a "hands-on/minds-on" instructional approach that includes student investigation, discovery, and application[1,2,3] c. depth of study (fewer concepts and skills) rather than breadth[1,2,3] d. balance between science content and process in classroom instruction[1,2,3] e. ongoing, authentic assessment of important learning outcomes for students[17,18] f. materials, strategies, and perspectives sensitive to diverse cultures, languages, genders, and learning styles[7]		
3. Teacher Development Program Activities a. are appropriately designed for adult learners[8,9] • focus on growth rather than defects • relevant and practical • focus on teachers' interests and concerns • link teachers to resources and support		

Components of Effective Practice	Intended Program	Actual Program
b. model teaching principles and strategies that can be transferred to the classroom[6,12,13]		
c. allow teachers to actively construct knowledge through hands-on activities[12,13]		
d. include the use of tools, methods, and processes of scientists[12,13]		
e. immerse teachers in the scientific process[12,13]		
f. include actual or simulated problems or challenges of "real world" science[12,13]		
g. are designed so teachers learn cooperatively in small groups[6,12,13]		
h. include opportunities to practice new classroom behaviors or strategies[6,12,13]		
i. include opportunities for teachers to plan for use of new knowledge and skills in their own classrooms, with their own curricula[8]		
j. include opportunities for teachers to work together, as they learn and plan for transfer to their individual classrooms[11]		

Components of Effective Practice	Intended Program	Actual Program
4. Unique Contribution of DOE Laboratories a. scientists and technicians • participate in program design, implementation, and evaluation • assist in developing scientific/technical content • collaborate with teachers to solve real/simulated problems • serve as role models (minorities, women, disabled, senior/retired) b. scientific/technical facilities and equipment are used for training, immersion, and science experiences c. the work being done (frontier science), both in the particular lab and in other DOE facilities, is the focus of teacher development activities 5. Follow-Up a. learning activities for teachers are spread out over time[6,12,13,14] b. follow-up focuses specifically on the use of new knowledge and skills in the classroom[6,14,15] c. teachers have the opportunity to try out new knowledge and skills in classrooms before follow-up occurs[12,13,14,15]		

Components of Effective Practice	Intended Program	Actual Program
d. follow-up takes a variety of forms, including additional training, problem-solving or sharing meetings, on-site or telephone consultation, networking through newsletters or telecommunications, training and support of local resource teachers or others to provide on-going assistance[12,13]		
e. long-term commitment includes material, moral, logistical, technical, and symbolic support from the laboratory, or as a result of arrangements made by the laboratory from the school or community[5,12,13]		
6. Teacher Leadership and Responsibility		
a. teachers take on leadership responsibilities in aspects such as program development, delivery, implementation, follow-up, and spread to other colleagues[10,14]		
b. teachers have input and/or involvement in decisions about the content, process, implementation, and/or evaluation of their learning experiences[12,13,14]		
c. teachers are given support by the lab for leadership and networking with people outside the program, such as teacher colleagues and professional associations[10]		

Components of Effective Practice	Intended Program	Actual Program
7. Program Evaluation a. monitoring of participant satisfaction during the program and follow-up activities identifies needed changes, which are made immediately, when appropriate and feasible[14] b. ongoing formative and summative evaluation of important program outcomes involves data collection from a variety of sources, with resulting changes in program design[14]		

Program Characteristics

1. Stated goals:

2. Program developers (names and roles):

3. Amount and distribution of contact time (e.g., two-week summer institute, three one-day follow-up sessions in October, December, February):

4. Nature of follow-up:

5. Program presenters (e.g., lab scientists, local teachers):

6. Scientific focus of lab reflected in teacher development program (e.g., nuclear physics, stream ecology, nuclear medicine):

7. Special lab facilities used in program:

8. Core science, mathematics, and technological competencies (e.g., applied and basic technologies, integration activities, product realization) used in program:

Characteristics of Target Population

1. Target is primarily:

   ☐ individual teachers (how many? _____)
   ☐ whole school(s) (how many? _____)
   ☐ whole district(s) (how many? _____)
   ☐ other (*specify*: _____) (how many? _____)

2. Approximate percentage of participating teachers working in each location:

   rural _____%
   urban, but not inner city _____%
   urban, inner city _____%
   suburban _____%

3. Average percentage of ethnic composition of schools of participating teachers:

   American Indian or Alaskan Native _____%
   Asian or Pacific Islander _____%
   Hispanic (regardless of race) _____%
   Black (not of Hispanic origin) _____%
   White (not of Hispanic origin) _____%

4. Approximate percentage at each school level:

   elementary _____%
   middle/junior high _____%
   high school _____%

5. Approximate percentage teaching classes in:

   science _____%
   mathematics _____%
   technical _____%
   other _____%
   (specify _____)

SECTION THREE

TEACHER DEVELOPMENT PROGRAMS TEMPLATE: Operational Definitions

Operational Definitions

"How would I know if I said it?" The following definitions are intended to help answer that question and to clarify components and subcomponents of the Teacher Development Program template. Some components are cross-referenced.

Component 1: Program Administration

(d) **Collegial Atmosphere:** An environment in which professional exchange is encouraged and mechanisms are created to make it happen. For example, opportunities are scheduled for teachers and/or scientists to discuss research or teaching topics; program staff are always accessible (have an "open door" policy); participants are encouraged to pursue their research interests by linking with scientists; conversation includes talk about work, the craft of teaching or scientific investigation; people listen to each other, value each other's contributions, treat each other as peers.

(j) **Underrepresented:** Refers to females, non-Asian minorities, and the poor. These groups whose established patterns of lower levels of school and adult accomplishments in scientific and quantitative fields put them educationally at risk in these subject areas (from *Indicators for Monitoring Mathematics and Science Education: A Sourcebook.* RAND Corporation, 1989).

Component 2: Vision for the Classroom

This component describes the kind of science programs labs want teachers to use with their students.

(a) **Deep Understanding:** Helping students learn so that they can apply their learnings to new situations, as opposed to superficial learning that they can merely parrot back.

Major science concepts or principles, development of skills, and "scientific habits of mind;" important outcomes of the science programs that lab staff are helping teachers to deliver to their students. Major science concepts or principles may be those called themes or organizing concepts in AAAS's *Science for All Americans* or reports from the National Center for Improving Science Education (NCISE) such as change, systems, or diversity, or they may be more specific, such as the concept of a food web or radioactivity. What is important is that there is not a focus on the learning of disconnected facts or vocabulary words. Skills include generic thinking skills (e.g., critical thinking, reasoning) science-related thinking or process skills (e.g., critical thinking, designing investigations, inferring, predicting), science lab skills (e.g., using equipment, measurement). "Scientific habits of mind" include attitudes and dispositions important to scientific thinking and investigations, such as honesty, skepticism, tolerance of ambiguity, desire for evidence. (See NCISE reports for more detail.)

(b) **"Hands-on/minds-on" Instructional Approach**: Labs help teachers develop an inquiry-based approach to teaching that not only includes hands-on experience or activities, but includes ways for students to develop new understandings from these activities. This may be through the use of a "teaching/learning model" such as the 4-stage one proposed by NCISE: (1) invitation to learn, (2) explore, discover, investigate, (3) propose explanations, (4) apply in different situations; or the "5E" model of BSCS: (1) engage, (2) explore, (3) explain, (4) elaborate, (5) evaluate; or another similar model. All these models emphasize questioning, investigation, and application -- with attention to pulling the learning together after investigation (not lecture or reading, followed by a lab experience for confirmation or reinforcement). They also avoid simply doing activities.

(c) **Depth of Study Rather Than Breadth:** Labs help teachers develop programs or teaching strategies that explore fewer concepts in greater depth than is common practice in schools, where the amount of vocabulary in science texts exceeds that in foreign language texts. Teachers need to be selective and delete or give superficial attention to some concepts and skills while exploring others in depth.

(d) **Balance Between Science Content and Process**: Inclusion of both knowledge and skills as important outcomes of school science.

(e) **Authentic Assessment**: The kind of assessment of student learning that measures student learning outcomes that are important (e.g., scientific principles, science process skills) rather than those that are easy to measure (e.g., facts and vocabulary); assessment is done in a way that truly demonstrates the learning that is valued (for example, having students actually use a thermometer to measure the temperature of the water in the beaker, rather than look at a picture of a thermometer in a beaker); authentic assessment is also done in the course of instruction, for the purpose of monitoring student understanding so activities can be adjusted or new ones designed, rather than solely for the purpose of a final indication of whether or not learning has occurred.

Learning Outcomes: see 2(a)

Component 3: Teacher Development Program Activities

(a) **Adult Learners**: Activities that are sensitive to the needs of adult learners have many attributes identified in the literature. These include: (1) a focus on growth rather than defects (e.g., activities model trying out new skills, getting feedback, and change; growth is rewarded; failure is expected and learned from); (2) activities are relevant and practical; (3) activities focus on individual interests and needs; (4) activities respond to the concerns or questions participants are asking; (5) activities link participants to and/or build in resources to support their learning (e.g., networking and mentoring).

(c) **Construct Knowledge:** People don't learn by memorizing, but rather by connecting new information to what they already understand. Developing new concepts and

strategies involves first being conscious of how one thinks things work (e.g., in the natural world or in the learning or teaching of young people), then fitting in the new ideas. Such "construction" of knowledge requires actual "hands-on" experiences and then opportunities to discuss, challenge each others' beliefs, and try out new ideas. The more that old and new ideas are discrepant, the more experiences and opportunities for discussion it takes for new ideas to replace or enhance old ones.

(e) **Immerse:** Actually get involved in, e.g., teachers actually do science activities whose outcomes are the generation of scientific knowledge (mirroring the kinds of activities the lab conducts).

(f) **"Real World" Science**: Related to applications of science in today's world: relevant, observable, applicable.

(g) **Learn Cooperatively**: Work together in learning teams where tasks of learning are shared; includes discussions of observations to develop a shared view of what is happening; opportunities to develop and present common report or product.

Component 5: Follow-Up

Follow-Up: Structured, planned actions that take place as part of the program design, following the first major program or event; for the purpose of continuing and enhancing the goals of that program. May include continuing communication, workshops, classroom support, information, mentoring, equipment loan, or extension of the activity to a larger unit.

Component 6: Teacher Leadership

Leadership: Having the capability and skills to act as an agent for change. Actions include communication with others about their experiences, presentations for professional organizations, being active in professional organizations, working with authorities to facilitate change, working with policy makers, serving as master or mentor teacher, and working across grade levels and/or schools to implement change.

Component 7: Program Evaluation

(b) **Formative and Summative Evaluation**: Formative evaluation is done for the purpose of program improvement; it often focuses on the programs' activities and the reaction of participants to those activities. It is best done while the program is in progress, so that changes can be identified, made, and continually evaluated. Summative evaluation is done for the purpose of making judgments about the worth of the program. It often focuses on the over-time impact the program has on participants, and is often done after the program is completed or has been in place long enough to have stabilized.

Descriptive and Context Information

Core Competencies: The set of basic areas of expertise and facilities upon which a specific laboratory builds its fundamental business (e.g., high energy physics, accelerators, materials science, high performance computing, etc.).

Integration Activities: Activities that integrate all required research data and/or programs, and other laboratory expertise into a single solution for a particular problem (e.g., the combination of systems studies, materials research, engineering, computer simulations, and field testing into a solution to the problem of transporting of hazardous materials).

Product Realization: The transfer of technology from the laboratories to the private sector, resulting in specific, marketable products.

SECTION FOUR

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